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Automated Smart Floor Cleaner for Reducing Human Efforts

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ABSTRACT

The main goal of the "Floor Cleaning Machine" is to create an automated floor cleaning system that can effectively clean a variety of floor surfaces without the assistance of a human. With its sophisticated sensors, motors, and cleaning systems, the machine will be able to detect and remove dirt and debris from a variety of surfaces, including carpets, tiles, hardwood floors, and more. The suggested system will be electrically driven and run on a series of pre-defined cleaning patterns that may be altered to satisfy particular cleaning needs. This study is anticipated to offer a time- and money-saving solution for keeping floor surfaces clean and hygienic in both home and business settings.

Keywords: IoT; Floor cleaner; Floor cleaning machine; Sensors; Motors; Cleaning systems.

1. Introduction

An automated device that can effectively clean diverse floor surfaces without human assistance is what the "Floor Cleaning Machine" project seeks to create and develop [1]. The concept uses cutting-edge sensors, motors, and cleaning systems that can recognise and remove dirt and debris from a variety of surfaces, including tiles, carpets, hardwood floors, and more. The suggested system will be electrically driven and run on a series of pre-defined cleaning patterns that may be altered to satisfy particular cleaning needs [2].

The need for automated floor cleaning systems has become increasingly important due to the rise in demand for cost-effective and time-efficient solutions for maintaining clean and hygienic floor surfaces in both residential and commercial settings [3]. The current manual cleaning methods are not only time-consuming but also require significant physical effort, which can lead to health problems for those involved in the cleaning process [4]. An automated floor cleaning machine can eliminate these challenges and improve the overall cleaning process by providing a more efficient and effective cleaning solution [5].

The proposed floor cleaning machine will be powered by electricity, and it will be programmed to operate on a set of pre-defined cleaning patterns. The patterns can be customized to meet specific cleaning requirements, such as cleaning in a particular direction, cleaning a specific area, or focusing on high-traffic areas [6]. The machine will also be equipped with sensors that can detect obstacles, walls, and other objects to ensure that it can navigate around the cleaning area without causing damage to the surrounding environment [7]. The study will involve the design and development of the floor cleaning machine, including the selection and integration of sensors, motors, and cleaning mechanisms [8]. The system will be programmed to operate on a set of pre-defined cleaning patterns that can be customized to meet specific cleaning requirements. The machine will be tested on various floor surfaces to ensure its effectiveness and efficiency in cleaning [9]. This project is expected to provide a cost-effective and time-efficient solution for maintaining clean and hygienic floor surfaces, which is crucial for the health and well-being of people in various settings [10]. The design and development of the floor cleaning machine will

involve several stages, including research, design, development, and testing [11]. The project's outcome is expected to provide a cost-effective and time-efficient solution for maintaining clean and hygienic floor surfaces, which is crucial for maintaining a healthy and safe environment in both residential and commercial settings [12]. An automated floor cleaning machine can also help reduce the physical strain associated with manual cleaning, which can improve the well-being of individuals involved in the cleaning process. Overall, the "Floor Cleaning Machine" project is a valuable initiative that can benefit society in many ways.

2. Existing Systems

This system uses an Arduino Uno microcontroller to process ultrasonic sensor data and drive a DC motor to navigate around obstacles [13]. The robot's cleaning mechanism is not described in detail, but the system offers a low-cost solution for automated floor cleaning. This robot can be used as a standalone cleaning module or attached to a vacuum cleaner to clean the floor. It has an EDF acting as a vacuum cleaner and a vacuum pump for spraying cleaning fluid. This system offers a cost-effective solution to achieve a clean floor [14].

Tetris Inspired Shape-Shifting Floor Cleaning robot's design is inspired by the game of Tetris and can change its shape to cover more area. The cleaning mechanism is similar to that of the previous system, with an EDF and vacuum pump for cleaning. This system offers a creative solution to cover a larger cleaning area [15]. Smart Vacuum Cleaner consists of an RC car with a vacuum cleaner attachment and an ultrasonic sensor to detect obstacles. The wheels' direction is controlled by the Arduino code, and the cleaner has space to collect dust. This system offers a user-friendly solution for cleaning small spaces [16].

Floor Cleaning Robot with Reconfigurable system exhibits the ability to alter its physical structure to assume any of the seven one-sided tetromino shapes, thereby optimising its coverage area. It has a high maintenance cost compared to fixed morphology robot platforms, but it offers a creative solution to maximize cleaning efficiency [17]. The hTrihex platform is a floor-cleaning robot designed to operate autonomously. It is capable of reconfiguring itself and adapting to three distinct configurationsp [18]. A cascade control strategy has been developed to govern the motion of hTrihex. The system must guarantee satisfactory closed-loop performance and asymptotic path tracking. This system offers a highly adaptable and efficient cleaning solution [19].

Automatic & Manual Vacuum Cleaning robot aims to make life easy and comfortable with advancements in technology. The system is low-cost and integrates with humans, unlike conventional cleaning robots [20]. The present system provides a significant resolution to the challenge of producing robotic cleaning devices utilising regional resources, while simultaneously maintaining cost-effectiveness [21]. Automatic Floor Cleaning robot design includes an effective chassis, sensors, a microcontroller, motor drivers, motors, and wheels for movement. The robot is capable of cleaning homes, schools, offices, and factories entirely. The system's goal is to build the robot economically and make it user-friendly for society [22]. Navigation System for Indoor Cleaning system addresses the issue of repetitive cleaning by cleaning robots due to their inefficient mechanism to record their trajectory. The system integrates a wireless network and human-machine interaction to promote the cleaning robot's working performance. This system offers a more efficient and effective cleaning solution. The current investigation concerns a novel autonomous floor cleaning device that incorporates an Android-based controller. The present

system is founded upon an Arduino MEGA microcontroller, a floor cleaning mechanism, and a mobile application that features wireless connectivity. The robot has been engineered to provide a cost-effective alternative and presents a vast array of features that are commonly found in commercially available robots. The system exhibits both autonomous and remote-controlled capabilities, albeit at a considerable cost. The aforementioned system provides a sophisticated cleansing resolution that incorporates the ability to be controlled remotely.

2.1. Challenge and Limitations of Existing Systems

- Limited Cleaning Power: Automated floor mop systems may not have the same cleaning power as traditional mops or other cleaning methods. They typically rely on microfiber pads or similar materials to remove dirt and debris, which may not be as effective as manual scrubbing or more heavy-duty cleaning methods. Additionally, automated systems may not be able to reach tight spaces or corners that require extra attention. While they can be useful for regular cleaning and maintenance, it's important to recognize that they may not be a complete replacement for traditional cleaning methods.

- Technical Malfunctions: Automated floor mop systems rely on complex mechanical and electronic components, which can be prone to technical malfunctions or breakdowns. These systems require regular maintenance, including cleaning and replacement of parts such as the motor, battery, and sensors. If any of these components fail, the system may not function properly and require professional repair. Moreover, the breakdowns could occur when the system is in use, which could cause inconvenience and even harm to the user.

- High Initial Costs: Automated floor mop systems can be expensive to purchase and install, especially for larger areas or multiple floors. The costs can vary depending on the brand, features, and complexity of the system, but they typically include the cost of the unit itself, replacement pads, cleaning solutions, and maintenance. While these systems may save time and effort in the long run, it's important to consider the upfront costs before making a purchase.

- Limited Flexibility: Automated floor mop systems are designed to clean specific types of floors and may not be suitable for all surfaces or cleaning requirements. For example, some systems are designed for hardwood floors, while others may be better suited for tile or laminate. Additionally, these systems may not be able to handle certain types of debris or stains. While some models may have adjustable settings or interchangeable pads, it's important to ensure that the system is compatible with the specific cleaning needs of the user.

3. Proposed System

The system's design was initiated by contemplating the trajectory for the purpose of cleansing the floor surface. Two alternatives were identified, namely a spiral trajectory or a zigzag trajectory. The two patterns were evaluated and contrasted in terms of their simplicity, efficacy, and duration of execution. The zigzag trajectory was deemed to be the more appropriate alternative for the envisaged system.

The electromechanical device commonly referred to as the automatic floor cleaner serves a multitude of functions within the realm of household applications. The design of this product is intended to efficiently clean targeted regions, thereby minimizing the amount of physical labour required by individuals. The primary objective was to

design a domestic cleaning apparatus that would enhance the ease and effectiveness of cleaning. The apparatus is outfitted with appendages affixed to its lateral surfaces, which amass particulate matter during locomotion.

The use of ultrasonic sensors is another critical feature of the proposed system. The sensors detect obstacles and change the direction of the cleaner while moving. This ensures that the cleaner does not fall from heights, making it safer to use. Additionally, the sensors help to prevent collisions with obstacles, which could damage the cleaner.

3.1. Methodology

The initial stage of the methodology entailed the contemplation of the path to be taken for the purpose of cleaning the floor surface. It was postulated that the operational region of the robot was a quadrilateral with four right angles. Two potential trajectories were identified as viable options: a spiral path or a zigzag path. The comparative analysis of the two path patterns was conducted, taking into account the factors of simplicity, effectiveness, and completion time.

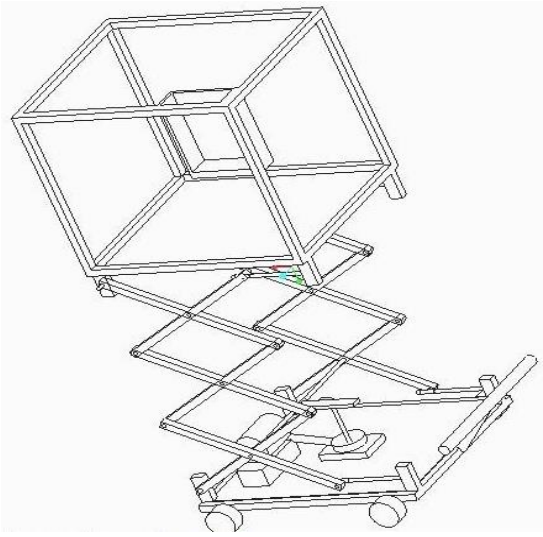

Figure 1. Side view

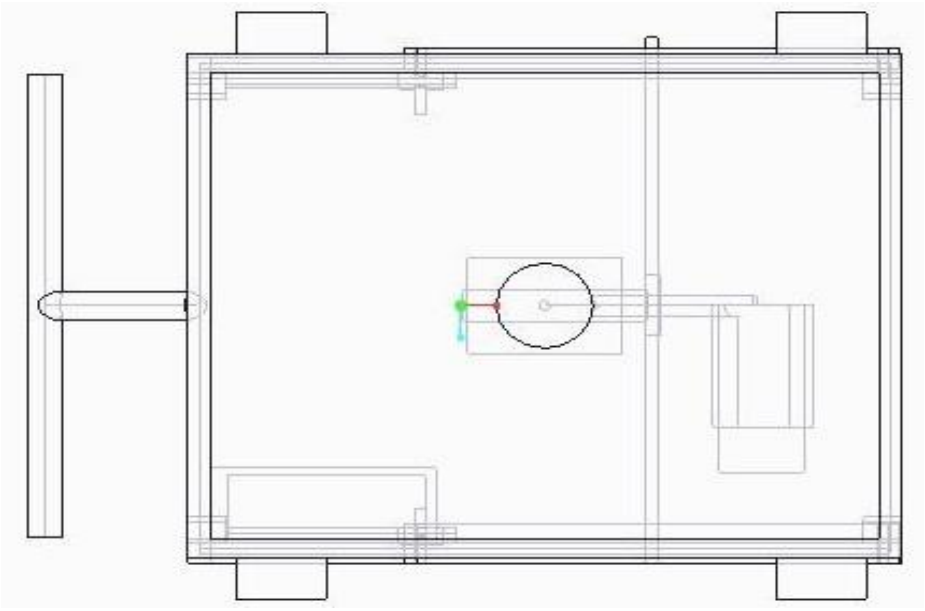

Figure 2. Top view

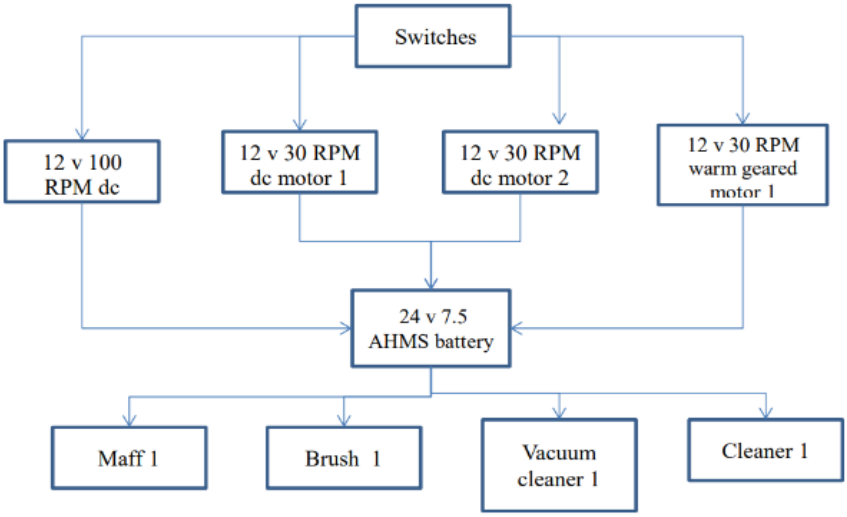

Figure 3. Block diagram

Design: The next step involved designing the system with the aim of reducing human effort in the task of floor cleaning. The system was designed to move around freely and clean a specific area by the vacuuming process. Brushes were attached to its sides in order to collect the dust while moving. Ultrasonic sensors were used to detect obstacles and change its direction while moving, preventing the cleaner from falling from height.

Programming: Once the design was finalized, the system was programmed to ensure that it could execute the desired path while cleaning the floor. The programming involved the use of sensors and algorithms that allowed the system to detect obstacles and change its direction while moving, ensuring that it cleaned the floor as intended.

Testing: After the programming was completed, the system was tested to ensure that it performed as expected. The testing involved running the system on different types of floors, in different environments, and for different durations to ensure that it cleaned the floor effectively and efficiently.

Improvement: Based on the results of the testing, the system was improved in order to ensure that it met the desired specifications. This involved making changes to the path planning, design, and programming, and re-testing the system to ensure that the changes were effective. Upon confirmation of the system's effectiveness and efficiency, it was implemented in diverse settings, including residential dwellings, hospitality establishments, dining establishments, corporate offices, medical facilities, storage facilities, and academic institutions.

4. Advantages and Applications

Reduced human effort: The system is designed to clean floors automatically, which reduces the need for human effort. This means that individuals can focus on other tasks, thereby increasing productivity.

Improved efficiency: The system is capable of cleaning floors in a more efficient and effective manner than traditional cleaning methods. This is because it is equipped with sensors that allow it to detect obstacles and navigate around them.

Time-saving: The automatic floor cleaner system can clean floors in a shorter amount of time than traditional cleaning methods, thereby saving time.

Improved safety: The system is equipped with sensors that allow it to detect obstacles and change direction to avoid falls from heights. This improves safety and reduces the risk of accidents.

Cost-effective: While the initial cost of the system may be high, it is cost-effective in the long run as it reduces the need for human labor and reduces the time required for cleaning.

Customizable: The system can be customized to meet the specific cleaning needs of different environments. This means that it can be used in a variety of settings, including homes, offices, hospitals, and warehouses.

Eco-friendly: The system is designed to be eco-friendly as it reduces the use of chemicals and water typically used in traditional cleaning methods.

4.1. Results

During the demonstration, the proposed automatic floor cleaner successfully cleaned a room using the implemented hardware setup and program. The cleaning performance was observed to be effective and efficient, achieving the desired level of cleanliness in the room. The cleaner also demonstrated its safety features by avoiding falls from heights, ensuring a secure and stable operation. The successful implementation and performance of the system validate the effectiveness of the proposed design and methodology, making it a promising solution for reducing human effort in floor cleaning applications.

5. Conclusions

In conclusion, the proposed automatic floor cleaner system has been successfully designed, built, and tested. The system has shown promising results in terms of cleaning efficiency, reduced human effort, and safety. The use of Ultrasonic sensors and brush attachments has improved the cleaning process by detecting obstacles and collecting dust while moving.

In terms of future scope, the system can be integrated with AI technology to enhance its functionality and intelligence. This can involve incorporating machine learning algorithms to improve the system's ability to navigate and detect obstacles, as well as to recognize different types of surfaces and adjust the cleaning process accordingly. Additionally, the system can be equipped with sensors to detect and map out the room layout, allowing it to create an optimal cleaning path and avoid previously cleaned areas. Moreover, the system can also be integrated with voice recognition technology to enable users to control the cleaner through voice commands, making the cleaning process even more effortless. The integration of these advanced technologies will improve the system's overall efficiency and user experience, making it a valuable addition to households, commercial spaces, and public institutions.

Declarations

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Competing Interests Statement

Authors have declared no competing interests.

Consent for Publication

The authors declare that they consented to the publication of this study.

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